Sona-Graph 7029-A Maintenance

KAY ELECTRIC CO.

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SONA-GRAPH 7029-A

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SECTION I

PRELIMINARY INFORMATION

1.1 INTRODUCTION

This manual presents information for the maintenance and alignment of the Sona-Graph 7029-A and the 6076-C Amplitude Display and Scale Magnifier plug-in unit. The specifications and operation procedures can be found in the Operator's Manual. For this discussion, reference may be made to the Functional Block Diagram, (Fig. 1.1), and to the Schematic Diagrams.

1.2 CIRCUIT DESCRIPTION, OVERALL

Record Mode:

The signal to be analyzed is fed into the MICROPHONE INPUT jack, which is the input to the record amplifier. The amplified signal is then applied to both the record head and the monitoring circuitry. Since the erase head is biased, the tape is always clean before it passes by the record head. Therefore, a continuous process of record and erase is taking place. Depressing the calibrate pushbutton feeds a calibration tone into the record amplifier, along with the input signal. The monitoring system permits the recorded and reproduce signals to be observed on the VU meter and heard on the speaker.

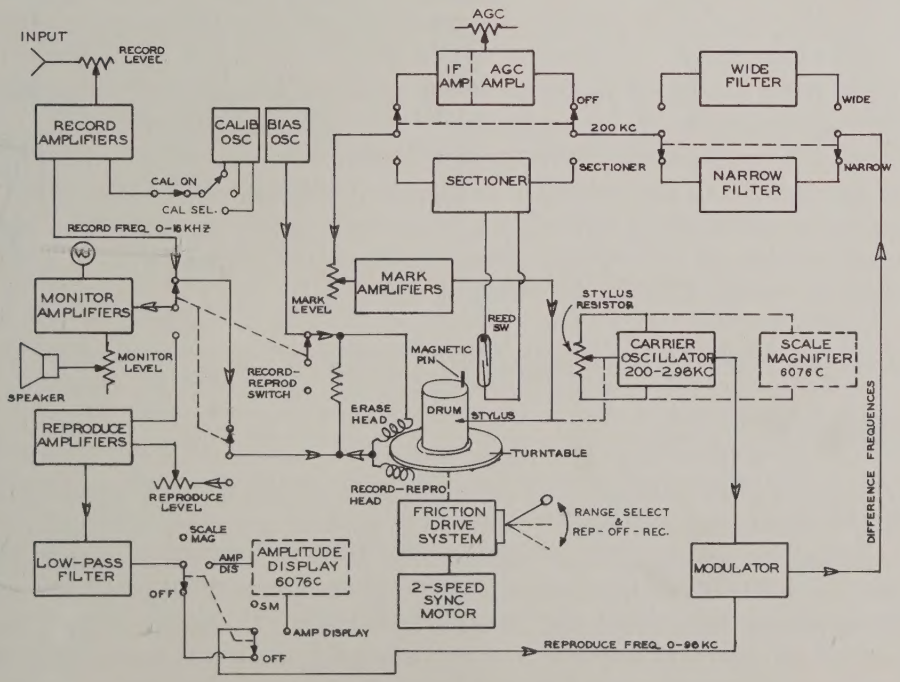


FIG. 1.1 FUNCTIONAL BLOCK DIAGRAM

Reproduce Mode:

The 7029-A has six record speeds as outlined in the Specification table in the Operating Manual. For the purpose of this discussion, only the 8 KHz range will be described.

As soon as the Sona-Graph is switched to the reproduce mode, the bias is removed from the erase head. This allows the last 2.4 seconds of recorded information to remain on the tape. The REC-OFF-REP switch on the mechanical portion of the 7029-A is placed in the REP position. The recorded signal is now being played back continuously at a speed of 300 RPM, (12 times faster than the record speed). As a result of this, a signal of 2 KHz, for instance, would be reproduced as a frequency of 24 KHz. Now the signal is amplified by the reproduce amplifier and passes through a low-pass filter whose cutoff frequency is 96 KHz. This filter limits the range of the Sona-Graph to 8 KHz maximum, (96 KHz divided by 12). The output of the low-pass filter is fed to one input of balanced modulator. The second modular input is obtained from the variable-carrier oscillator which has a range of 200 to 296 KHz. When the stylus is at the bottom of its travel, the oscillator frequency is 200 KHz; as the stylus moves up the paper, the frequency increases to 296 KHz at the upper extreme. The balanced modulator mixes the reproduced signal with the carrier oscillator and the resultant signal is fed to the NARROW-WIDE filters which have a center frequency of 200 KHz.

This process of mixing and filtering enables the Sona-Graph to scan the recorded signal. As an example, assume that a constant tone of 5 KHz has been recorded. When this signal is played back and fed into the balanced modulator, it will have been increased to 60 KHz. The stylus is now set at the bottom of the paper, causing the carrier oscillator to generate 200 KHz. Thus, the output of the balanced modulator consists of the sum and the difference frequencies, (260 KHz and 140 KHz). The 200 KHz filter will not pass either of these signals; therefore, the mark amplifier receives no input and there is no indication shown on the Sonagram paper. This process will continue, as the stylus is driven and a mark is produced on the paper. When the stylus passes this point, the filter will reject all signals as it did previously.

The dynamic range of the Sonagram paper is 10 DB; however, through the use of the AGC circuit, input signals up to 40 DB may be analyzed. When a section is being made, signals up to 35 DB can be displayed, (eliminating the need for the AGC). A reed switch, activated by magnetic pins on the drum, enables the sectioner to sample the signal under examination. The output of the AGC circuit or sectioner is then applied to the mark amplifier which furnishes the necessary voltage and current for the stylus. Since the Sonagram paper is current sensitive, as the signal strength increases the pattern becomes darker.

1.3 CIRCUIT DESCRIPTION, AMPLIFIER-ANALYZER SYSTEM

Record-Amplifiers:

Record pre-amplifier, Q-1401 & Q1402 provides for low impedance (MIC) input signals. When the INPUT SELECTOR switch is in either of the HIGH LEVEL position, the PRE-AMPLIFIER stage is by-passed and the signal is fed directly to the RECORD LEVEL control. This attenuated signal is then passed to the input of the RECORD AMPLIFIER (Module #1). Amplifier Q-101 provides a high impedance input and gain. A shaping network is employed in the emitter circuit of Q-102 for the HS analysis and provides an output for the VU & metering system. The collector output provides gain for differential amplifiers Q-103 and Q-104 whose output is coupled to Q-105, an emitter follower, for low output impedance. The signal is then fed to the RE-

CORD-REPRODUCE head and impressed on the magnetic plating of the turntable. A feedback path is employed from the head to the base circuit of Q-104, providing a flat record current. Tuned circuits L-101, C-109, C-110, and C-111 are utilized to keep 75 KHz bias signals from feeding back into the RECORD AMPLIFIERS.

Bias Oscillator:

Record-Erase Bias Oscillator, Q-205, Q-206, is activated either when the RECORD-REPRODUCE switch is in the RECORD position or when the CALIB switch is depressed. The oscillator produces a bias frequency of approximately 75 KHz. The output is fed to the head assembly and adjusted so that current is applied through the RECORD and ERASE heads. As both heads are biased simultaneously, a continuous process of recording and erasing is taking place until the RECORD-REPRODUCE switch is placed in REPRODUCE. At this time the recorded signal is "captured" on the turntable.

Calibrate Oscillator:

The calibrate oscillator consists of two multivibrators, one operating at 50 Hz and the other at 1000 Hz. Each output is fed into an amplifier and a shaping network to provide sufficient harmonic output. The output of the 1000 Hz oscillator is also coupled into a divide by 2 circuit to produce a 500 Hz signal.

Reproduce Amplifiers:

REPRODUCE PRE-AMPLIFIER, Q-1601 provides a high impedance input and low frequency pre-emphasis. The output is coupled to Q-1602 & emitter follower, Q-1603. The emitter follower utilizes a 200 KHz filter in its output circuit which filters out any 200 KHz signals. After being attenuated by the REPRODUCE LEVEL control, the signal is fed to the REPRODUCE AMPLIFIER, (Module #2). Amplifier Q-201 and Q-202 are similar circuits providing high frequency shaping. Amplifier Q-203 contains a tuned circuit, L-201, C-1212, and C-213, to provide additional shaping at high frequencies. The output from the collector of Q-203 is coupled to emitter follower Q-204 which provides a low impedance to the low pass filter which is tuned to reject all frequencies above 96 KHz.

Monitor & VU Amplifier

A portion of the REPRODUCE OUTPUT is passed to the INPUT of the MONITOR & VU AMPLIFIER, (Module #3). Amplifier, Q-303, is activated only in REPRODUCE. In the RECORD mode the signal is passed directly to the base of Q-301. Diodes D-301 and D-302 provide switching of the proper signal (RECORD OR REPRODUCE) to Q-302. Amplifier Q-302 provides the gain necessary to supply the VU meter. Diodes D-1201 thru D-1206 protect the meter from transients encountered when switching the mode of operation from RECORD to REPRODUCE and vice-versa. The MONITOR LEVEL controls the amount of signal applied to the base of the amplifier, Q-304. The signal then passes through emitter follower, Q-305, audio amplifier, Q-306, and is impressed across output transformer T-2, which matches the impedance of the speaker. A portion of the AUDIO OUTPUT is fed back to the emitter of Q-304, thus controlling the audible signal.

AGC Amplifier

The output of the PLUG-IN FILTER may be selected to take one of two paths. When producing a #1 display and AGC action is desired, the signal is fed to the input of AGC & IF Module #5, where it is passed through three transformer-coupled amplifiers, Q-501, Q-502 and Q-503. The output of Q-503 is coupled to amplifier, Q-505 and emitter follower, Q-504. This signal is then rectified and controls the biasing of the bases of Q-501, Q-502 and, thus, the gain of these stages. CR-501, in conjunction with the AGC action will be utilized to compress a full 40 DB of input to 10 DB, the range of the paper. For lower AGC control settings, the action will be cut out sooner, thus providing less compression.

When the AGC control is turned off, the filter output is fed to the base of Q-503, amplified, and passed to the IF OUTPUT: no compression is obtained.

Sectioner

To produce a #2 display, (SECTION), the FILTER OUTPUT is fed to the input of the SECTIONER, (Module #8). Here the signal is passed through a series of amplifiers, rectified, and fed to the normally open contact of the Mercury-wetted relay, RV-801, in the form of a negative DC voltage, proportional to the amplitude of the input signal. This voltage charges capacitor C-805. The reed switch, S-11, mounted on the top of the stylus housing, is normally in the open position, When a magnetic pin passes the reed switch, the circuit is closed and the mercury-wetted relay is energized. The voltage on C-805 places a charge on C-807. When the magnetic pin has passed the reed switch, the relay is de-energized and C-807 discharges through R-812 and R-813, producing the familiar exponential decay curve at the base of emitter follower, Q-804. Q-805 acts effectively as a switch, which, under no signal conditions, shorts the base of Q-806. When the negative negative exponential signal appears, Q-805 is cut off, thus removing the short from Q-806. This allows Q-806, operating in conjunction with Q-807, to function as a multivibrator which oscillates at 200 KHz. The resultant output is a pulse, proportional in length to the amplitude of the input signal, (measured in DB), when a magnetic pin passes the reed switch. When the SECTIONER switch is ON, the voltages across the stylus resistor are inverted, thus producing a range of 8 KHz at the lower SHORT POINT to 0 KHz, (baseline), at the upper SHORT POINT.

Carrier Oscillator & Modulator

The REPRODUCE OUTPUT is also fed through emitter follower, Q-401, to modulator transformer, T-402. At the same time, a voltage is impressed across the two legs of resistor, R-9, located in the stylus housing. The wiper contact of this resistor is mechanically linked to the Stylus Control and, as it moves up the Lead Screw, causes a constant voltage change at varactors, C-416 and C-417. This in turn causes the capacitance of the varactors and the frequency of Wien-Bridge Oscillator, Q-403 through Q-405, to vary in proportion. In the LINEAR mode of operation, LIN UPPER and LIN LOWER limit pots, R-1702 and R-1707, provide the proper voltage spread across the stylus resistor. Q-1701 provides the necessary voltage shaping needed to obtain uniform frequency variation with given stylus changes. In the LOG mode, R-1704, LOG UPPER, and R-1708, LOG LOWER limit pots control the voltage spread, while I-1701, a voltage variable resistance, provides a logarithmic voltage swing as the stylus moves up the screw. The output of the oscillator, (200 KHz - 296 KHz), is amplified by Q-402, and applied to modulator transformer, T-402. The sum, difference and carrier frequencies are present at the output of balanced modulator, CR-401 through CR-404. (A perfectly balanced

modulator would permit no carrier leak; however, the modulator has been purposely unbalanced to provide a reference baseline when the stylus is just above the lower SHORT POINT). Q-1001, in the PLUG-IN FILTER, provides the correct impedance match for crystal filters, FL-1001 and FL-1002, and compensates for the different insertion loss of these two filters. Both filters are tuned to pass only 200 KHz at the effective bandwidths of 45 Hz and 300 Hz referred to the record speed. (The actual filter bandwidths are 12 times these frequencies). Therefore, only the carrier leak and difference frequencies of 200 KHz will be amplified and present at the output. Q-1002 matches the output impedance of the filters and provides additional gain.

Mark Amplifier:

The output of either the SECTIONER or AGC circuits, depending on the mode of operation, is passed through the MARK LEVEL control to the input of the MARK AMPLIFIER. This 200 KHz signal is taken from emitter follower Q-701 and passed to amplifier Q-702. It is the transformer coupled to power amplifiers, Q-703 and Q-704. The outputs of these stages are impressed across transformer T-1, which steps up the RF signal to approximately 1000 volts, needed to burn the Sonagram paper.

1.4 DESCRIPTION, MECHANICAL SYSTEM

Record-Reproduce and Erase Heads

Fig. 1.2 shows the manner in which the heads are mounted and make contact with the turntable. Two heads are employed: PU-1 is used for recording and reproducing; PU-2 for erasing. Both heads must be in intimate contact with the recording surface at all times. A ratchet control is provided at the pivot point of each of the heads for the adjustment of head pressure.

Turntable And Drive System

The outer rim of the turntable is surfaced with a magnetic plating which is used for a recording medium. A synchronous, 2-speed motor, in conjunction with a friction drive system, causes the turntable to rotate at the selected speed when recording, and at 300 RPM when reproducing. The RECORD-OFF-REPRODUCE switch selects the mode of operation and controls the blower operation of the motor.

Stylus Assembly and Drum

The small drum, on which the Sonagram paper is placed, is approximately 4" in diameter and 7" high. A micrometer plate, the drum and the turntable are locked together with a large knurled nut mounted on the top of the micrometer plate. The drum and turntable, being keyed to a common axis, rotate in synchronism. Two rolling springs are provided to hold the Sonagram in place around the drum. The lead screw, mounted on the stylus housing, is coupled in the drum assembly through a gear and pulley system. The gear ratio controlling the lead screw is such that 96 lines are produced on the Sonagram as the stylus moves one inch up the lead screw. The stylus itself is a length of 10 mil stainless steel wire, mounted in the throat of the hard rubber, fume exhaust tube. A bakelite disc, on the rear of the exhaust tube, permits the operator to adjust stylus pressure.

The stylus assembly also includes provisions for controlling the frequency limits of the Sona-Graph. An arm of the stylus control lever extends into the stylus housing and controls two wiper contracts. One contact moves up a cermet resistor, R-9, thus controlling the varactor bias and

the frequency of the carrier oscillator. The second contact moves up a strip which contains two grounded terminals approximately 4" apart. When the stylus control reaches either of these short points, the input of the MARK AMPLIFIER board is board is shorted to ground, preventing any stylus marking and causing SHORT POINT indicator, I-1, to light.

The REED SWITCH BLOCK AND POINTER, both a part of the SECTIONER circuit, are located on the top of the stylus housing. When the SECTIONER circuits are activated, a magnetic pin passing the reed switch will close the circuit and energize relay RV-801 in the sectioner circuits. The pointer can be utilized in conjunction with the stylus wire to SECTION a pre-selected portion of #1 display.

Blower Motor Assembly

In the process of making a Sonagram, a considerable amount of smoke is generated. This smoke is drawn off via the hard rubber tube on the stylus holder and is passed through a flexible rubber tube which terminates at the filter and blower motor assembly.

1.5 CIRCUIT DESCRIPTION, AMPLITUDE DISPLAY/SCALE MAGNIFIER, 6076-A

When the SCALE MAGNIFIER-AMPLITUDE DISPLAY selector is in the AMPLITUDE DISPLAY position, the reproduce output is applied to the base of amplifier Q-1101. With the NORMAL — -10 DB switch in the -10 DB position, a voltage divider is inserted in the input circuit, providing 10 DB of attenuation. The output of Q-1101 is passed to phase-splitter Q-1102. Two outputs, the emitter in phase, and collector 180^{o} out of phase with the input, are fed to amplifiers Q-1104 and Q-1103, respectively. A portion of the output of Q-1104 is shaped by CR-1101 through CR-1104, and fed back to the base of Q-1102. The outputs of Q-1103 and Q-1104 are fed to rectifiers CR-1106 and CR-1105. This signal is then filtered and a DC control voltage is present at varactors C-1124 and C-1125.

When the BASELINE switch is depressed, the base of Q-1101 is grounded, thus allowing no signal to pass. The oscillator frequency in this condition, is adjusted so that Wien-Bridge oscillator, (Q-1105, Q-1106, and Q-1107), produces a baseline frequency of 62 KC. As the BASELINE switch is released, any fluctuation of the input amplitude, (in DB), will cause a proportional, linear change in frequency at the output of the oscillator.

When the SCALE MAGNIFIER-AMPLITUDE DISPLAY switch is in the SCALE MAGNIFIER position, the UPPER and LOWER LIMIT controls are placed at their respective ends of the stylus resistor, R-9. The wiper of this resistor is connected to the base of Q-1108. The UPPER and LOWER LIMIT controls thus determine the voltage spread present at Q-1108. These voltages are then passed through the emitter follower and zener diode shaping network, CR-1109 through CR-1111, which provide for the desired carrier oscillator frequency change with a corresponding change in position of the stylus control.

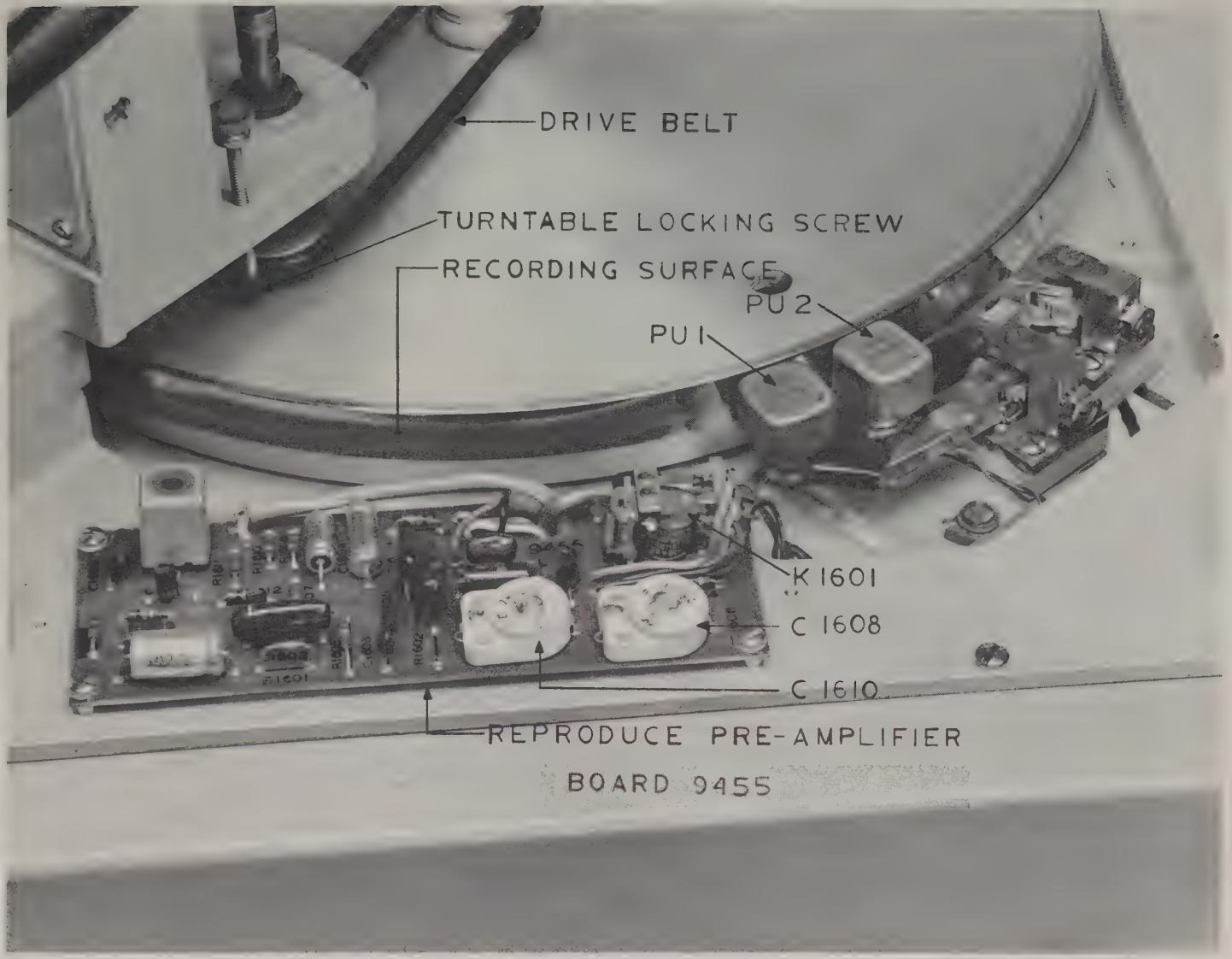


FIG. 1.2 MECHANICAL RECORD-REPRODUCE SYSTEM

SECTION II

ALIGNMENT PROCEDURE

2.1 INTRODUCTION

This section contains all the information necessary to complete a factory alignment of the Sona-Graph, 7029-A and the 6076-C plug-in unit. If any problems are encountered while performing these alignment checks, consult the maintenance section for possible malfunctions.

2.2 FUNCTION OF INTERNAL CONTROLS, 7029-A

CONTROL	COMPONENT	FUNCTION
B+ ADJ	R-905	Adjusts the proper 18v output from the power supply.
LOG UPPER LIMIT LOG LOWER LIMIT LIN UPPER LIMIT LIN LOWER LIMIT	R-1704 R-1708 R-1702 R-1707	Adjustments for setting the proper voltages at the top and bottom of the stylus resistor to provide correct frequency spread.
BIAS ON-OFF switch	S-1 (OFF)	De-activates the bias oscillator circuits, (used during alignment of record circuits.
BIAS ADJ	C-1608	Controls amount of bias applied to the record head.
75 KHz TRAP ADJ	C-1610	Keeps 75 KHz bias signal from feeding back into the record amplifiers.
200 KHz TRAP ADJ	L-1601	Tuned to keep 200 KHz signals out of the reproduce amplifier.
RECORD VU ADJ REPRODUCE VU ADJ	R-305 R-312	Control the amount of record and reproduce signal present at the VU meter.
MODULATOR BALANCE	R-407	Provides the correct balance between the carrier and reproduce frequencies.
FEEDBACK ADJ	R-415	Controls the amount of negative feedback required to cause the carrier oscillator to oscillate.
0 DB ADJ 20 DB ADJ 40 DB ADJ	R-503 R-509 R-524	Controls AGC diode action. Controls IF amplifier gain. Controls AGC amplifier gain.

50 Hz ADJ 500 and 1000 Hz ADJ	R-603 R-618	Controls frequency of the calibration oscillator.
MAXIMUM AMPL ADJ	R-812	Controls the maximum length of the sectioner pulse.
MINIMUM AMPL ADJ	R-824	Controls the minimum length of the sectioner pulse.

2.3 ALIGNMENT PROCEDURE, SONA-GRAPH, 7029-A

EQUIPMENT REQUIRED:

Oscilloscope, Tektronix 503, or equiv.
AC Voltmeter, Ballantine, Mod. #861, or equiv.
Attenuator, 70 ohm, Kay Mod. 21-0
Frequency Counter, Berkeley/Beckman Mod. #554 or equiv.
Audio Oscillator, Hewlett-Packard, Mod. 220-C or equiv.
DC Voltmeter, RCA Voltohmyst, or equiv.

A. POWER SUPPLY

1. Connect a VTVM and oscilloscope across C6, and check for +18 volts with less than 2 mv p-p ripple. Adjust R-908 if necessary.

2. Connect the VTVM and oscilloscope across CR-912, and check for -6.8 volts with less than 10 mv p-p ripple. This voltage should be within ±10%.

3. Measure between the (-) side of C-905 and ground; check for -36 volts with less than 2 volts p-p ripple. This voltage should be within ±20%.

   NOTE: If any printed circuit modules are plugged in or taken out of the Sona-Graph, make certain the unit is turned off. This is to prevent transients from damaging the semiconductors.

B. RECORD BIAS

1. Turn the bias switch, at the rear of the electrical unit, to ON.

2. Turn the RECORD-OFF-REPRODUCE switch to RECORD.

3. Connect one lead of a wide-band AC voltmeter to the relay side of R-1614, and connect the other meter lead to ground.

4. Tune C-1608 to obtain a 2.4 volt RMS reading on the meter.

5. Connect the scope, with a high-impedance probe, to the RECORD OUTPUT test jack.

6. Tune C-1610 for a minimum reading on the scope (4 volts p-p or less).

C. CALIBRATE TONE

1. Connect a counter to the CALIBRATE switch wiper arm. Place the switch in the 50 Hz position.

2. Adjust R-603 for a reading of 50 Hz on the counter.

3. Place the switch in the 1 KHz position. Adjust R-618 for a reading of 1 KHz on the counter.

D. 200 KHz TRAP

1. Turn the BIAS switch at the rear of the unit to OFF, the Mechanical Shift Level to OFF, and the RECORD-REPRODUCE switch to REPRODUCE.

2. Connect a 200 KHz oscillator (240 mv p-p) to the base of Q-1610 in the Reproduce preamplifier.

3. Connect the scope to the junction of R-1611 and L-1601, and tune L-1601 for a minimum reading on the scope.

E. CARRIER OSCILLATOR

1. Set the MARK LEVEL control at (0), and the BASELINE control at midpoint.

2. Connect a counter to the CARRIER OSCILLATOR test jack through a 100 K resistor.

3. Move the stylus to the top of its travel; then slowly bring it down until the SHORT POINT light goes out. Partially engage the stylus. (DO NOT ALLOW THE STYLUS WIRE TO TOUCH THE DRUM).

4. Turn the FREQ. SCALE to the LIN position.

5. Connect the positive lead of a VTVM to the junction of C-416 and C-417 (no Module #4). and the negative lead to chassis ground. Then adjust the LIN UPPER pot (R-1702) for a 10 volt meter reading.

6. Remove the VTVM and adjust R-415 to obtain a 296.7 KHz reading on the counter. Succeeding 296.7 KHz linear adjustments are to be done with LIN UPPER CONTROL.

7. Switch the FREQ. SCALE selector to the LOG position, and adjust the LOG UPPER pot (R-1704) to obtain 296.7 KHz.

8. Lower the stylus to the bottom of its travel; then slowly raise it until the SHORT POINT light just goes out. Partially engage the stylus.

9. Adjust the LOG LOWER pot (R-1708) to obtain 199.7 KHz on the counter.

10. Turn the FREQ SCALE switch to the LIN position, and adjust the LIN LOWER pot (R-1707) to obtain a 199.7 KHz reading.

11. Recheck the UPPER LIMIT frequencies, and readjust the pots if necessary. (Do not re-adjust R-415).

F. RECORD-REPRODUCE HEAD

1. Turn the shaping selector to FL-1, and the BIAS switch (rear of unit) to OFF.

2. Turn the RECORD-REPRODUCE switch to RECORD and the RECORD LEVEL CONTROL to approximately (20).

3. Feed in a 2.5 KHz signal and turn the INPUT SELECTOR to the appropriate matching impedance.

4. Monitor the junction of R-1614 and the relay (on the mechanical unit) with a wide-band AC voltmeter. Adjust the input to obtain a reading of 240 mv rms.

5. Turn the BIAS switch to ON, place the RECORD-OFF-REPRODUCE switch in RECORD, place the RANGE switch in the 8 KHz position. Record the 2.5 KHz signal.

6. Now monitor the head output in REPRODUCE by connecting the AC voltmeter to the input of the Reproduce Pre-amplifier. Adjust the heads until an output of 40 db above 1 mv is obtained. Re-record the 2.5 KHz signal after each adjustment.

7. If the proper reading cannot be obtained in Step 6, the bias noted in Step B-4 may be varied slightly (±10%).

G. SYSTEM FLATNESS

1. Set the SELECTOR switch to FL-1, and the INPUT SELECTOR to the correct matching impedance for the CW oscillator.

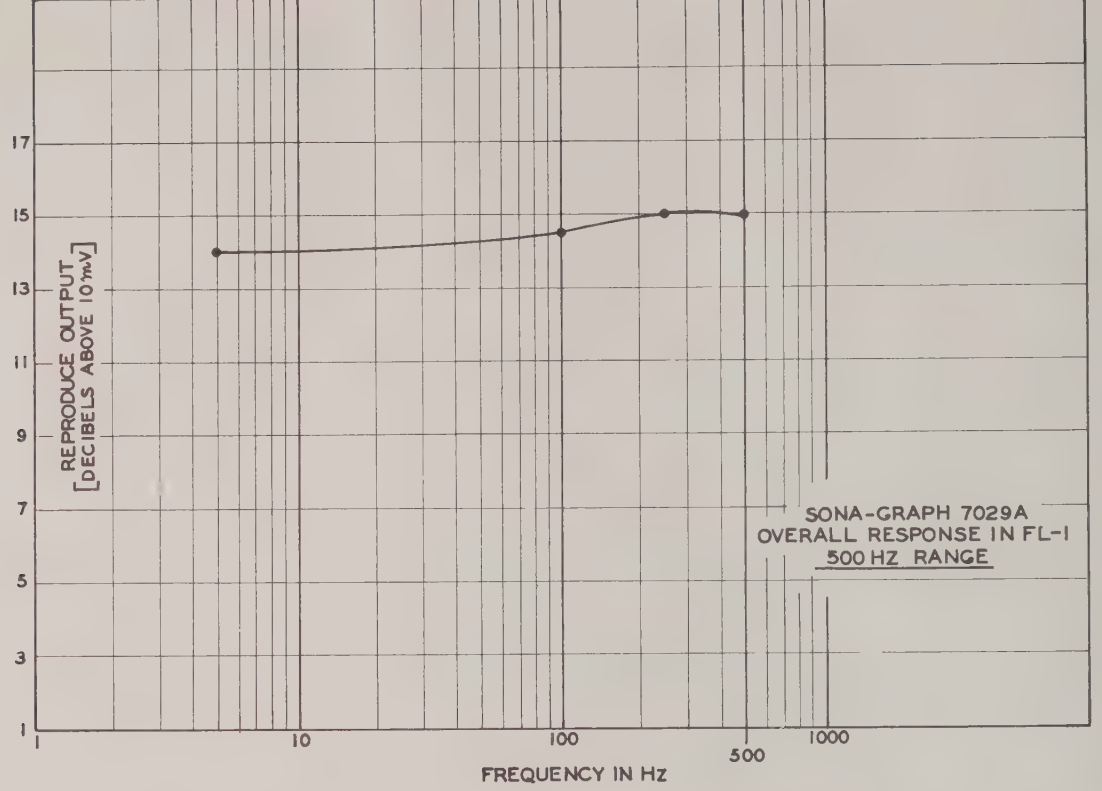
2. Set the RECORD-REPRODUCE switch to RECORD, the BIAS switch to OFF, and the REC-OFF-REP switch to RECORD.

3. With the AC voltmeter on the relay side of R-1614, apply a 2.5 KHz signal to the INPUT jack and set the oscillator for a 240 mv rms reading on the meter.

4. Check to see that there is a zero VU reading on the panel meter. If the reading is improper, adjust R-305 (Module #3) to obtain zero VU.

5. Return the BIAS switch to ON, and record the 2.5 KHz signal on the 8 KHz range.

6. Reproduce the signal in the normal manner, and monitor the REPRODUCE OUTPUT test jack with the AC voltmeter.



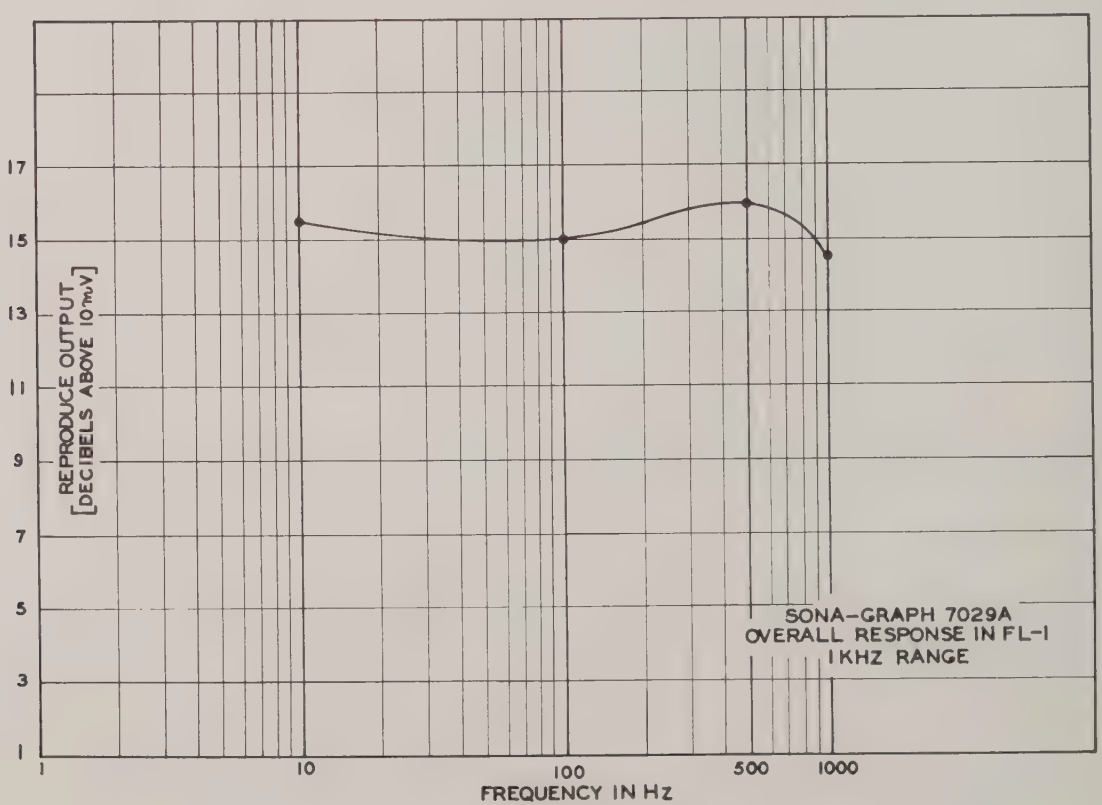
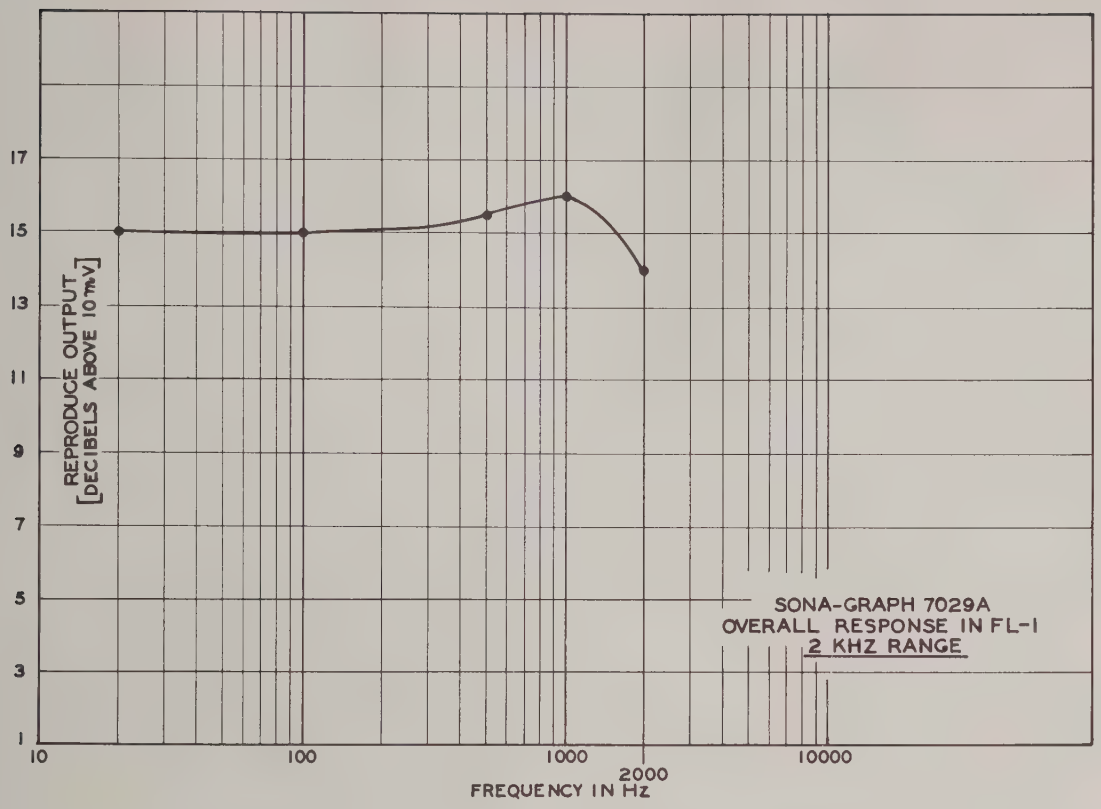
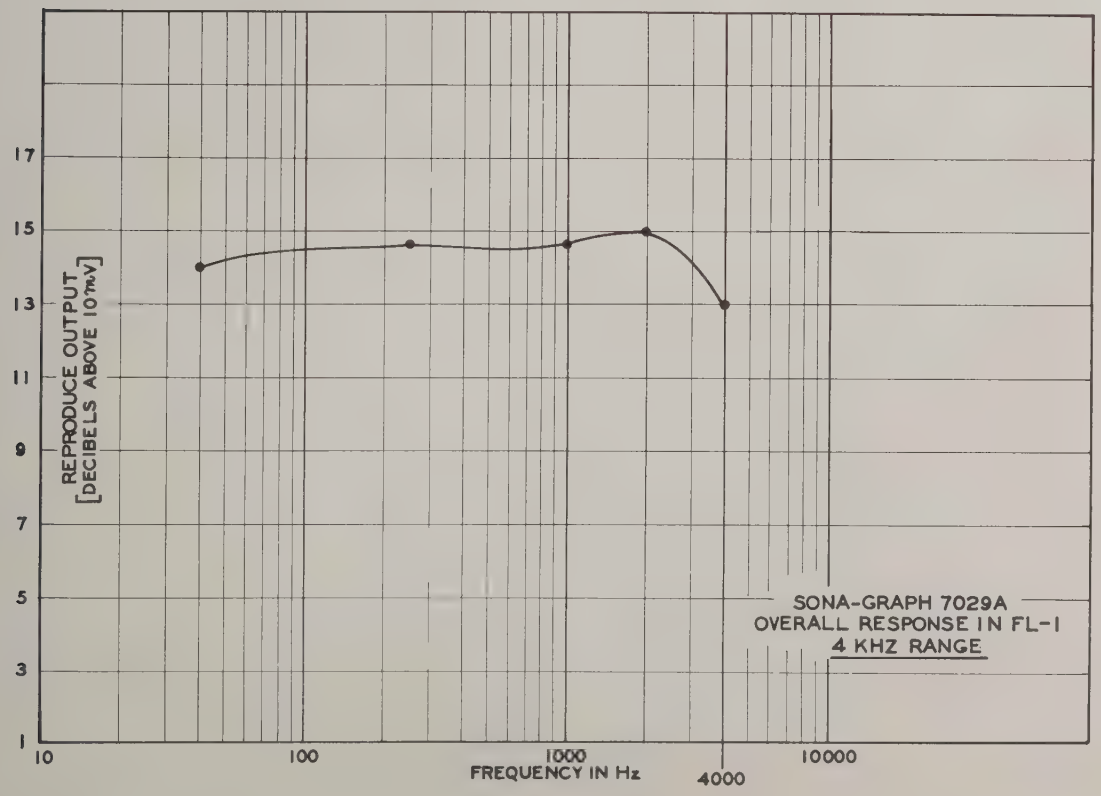
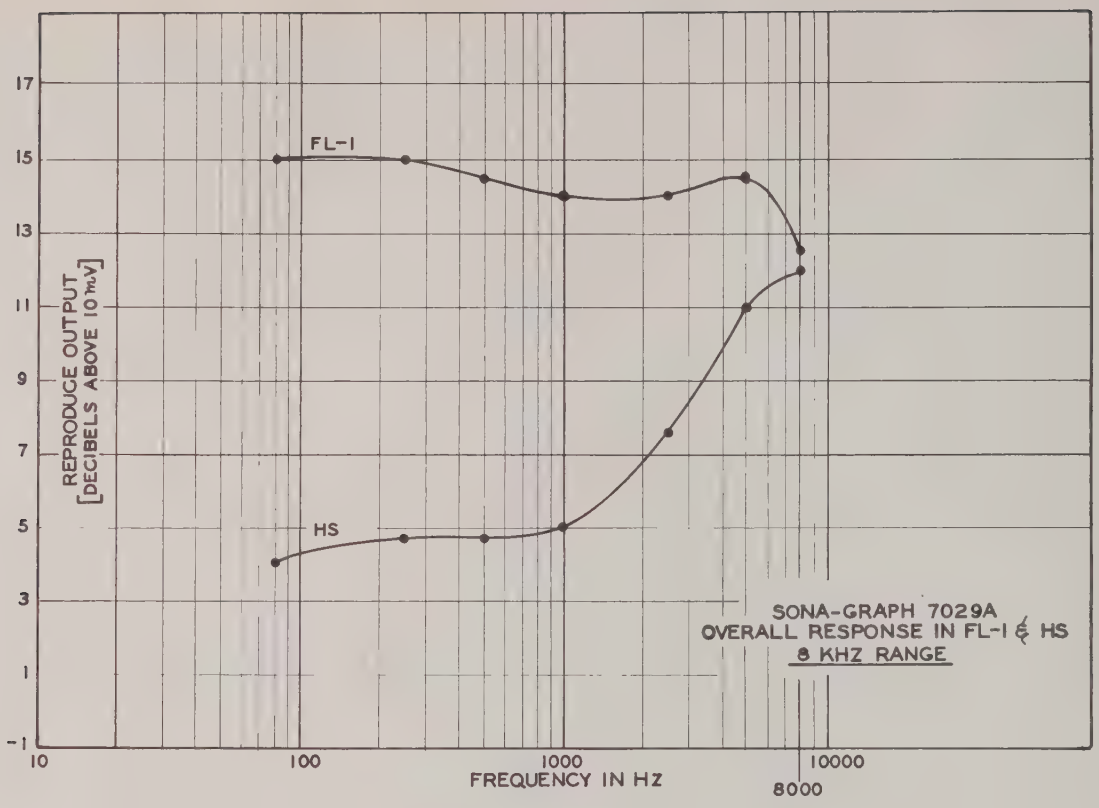
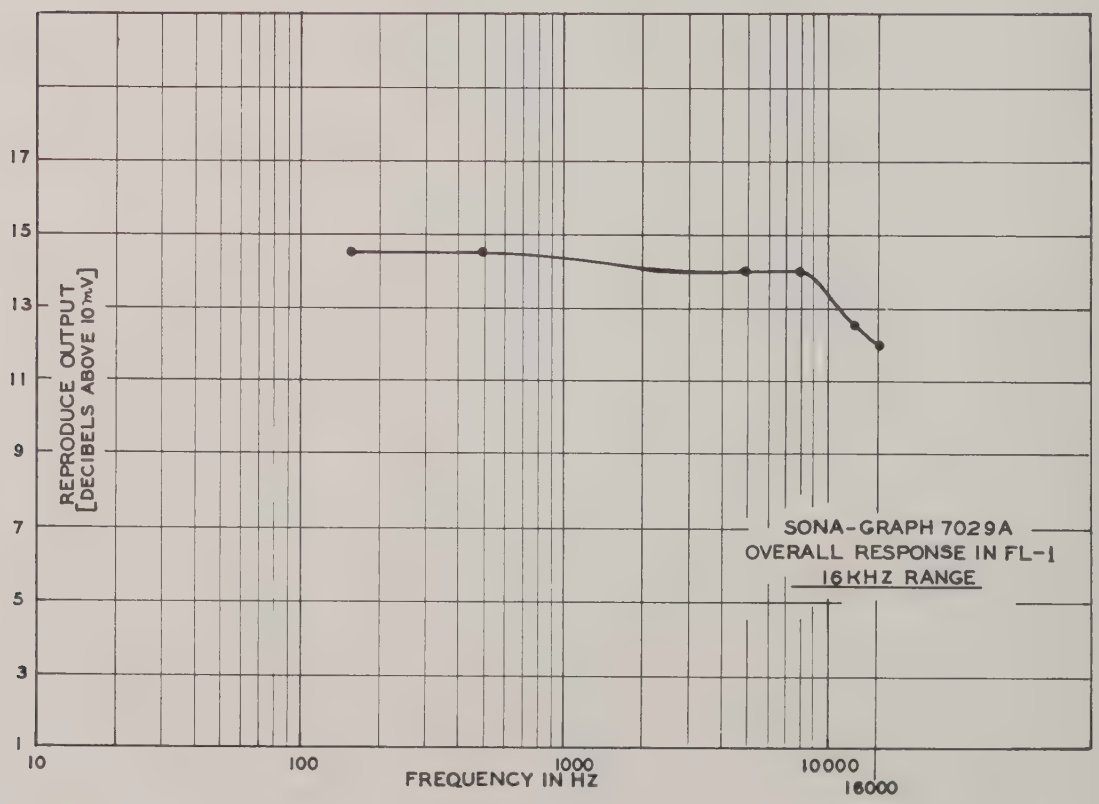


FIG. 2.1 TYPICAL OVERALL FREQUENCY RESPONSE CURVES


REPRODUCE OUTPUT
[DECIBELS ABOVE 10 mV]
17
15
13
11
9
7
5
3
1
10
100
1000
2000
10000
FREQUENCY IN Hz
SONA-GRAPH 7029A
OVERALL RESPONSE IN FL-1
2 KHZ RANGE


REPRODUCE OUTPUT
[DECIBELS ABOVE 10 mV]
17
15
13
11
9
7
5
3
1
10
100
1000
4000
10000
FREQUENCY IN Hz
SONA-GRAPH 7029A
OVERALL RESPONSE IN FL-1
4 KHZ RANGE


17
15
13
11
9
7
5
3
1
-1
REPRODUCE OUTPUT
[DECIBELS ABOVE 10 mV]
FL-1
HS
10
100
1000
10000
8000
FREQUENCY IN HZ
SONA-GRAPH 7029A
OVERALL RESPONSE IN FL-1 & HS
8 KHZ RANGE


17
15
13
11
9
7
5
3
1
REPRODUCE OUTPUT
[DECIBELS ABOVE 10 mV]
10
100
1000
10000
16000
FREQUENCY IN HZ
SONA-GRAPH 7029A
OVERALL RESPONSE IN FL-1
16 KHZ RANGE

7. Set the REPRODUCE LEVEL control to obtain approximately 80 mv volts rms on the meter.

8. Maintaining the same input level, record and reproduce signal frequencies throughout the 80-8000 Hz range. The AC voltmeter readings should not vary by more than ±2 DB over the entire range (Fig. 2.1).

9. If the flatness is slightly out of specification, the bias level may be changed by a small amount (±10%) to improve the response.

NOTE: It should be ascertained that the Record-Reproduce heads and the recording surface are clean before performing Steps F & G.

H. REPRODUCE VU METER

1. Leave the 7029-A set up as it was for the System Flatness check (the 2.5 KHz signal being played back continuously.

2. Connect vert of scope to FILTER OUT jack. Lift the stylus to a point where an IF output is observed on the scope. This will occur approximately one-third the way up the Lead Screw.

3. Move the stylus carefully until the peak output is noted; then turn the REPRODUCE LEVEL control to obtain 0.55 volts p-p (±10%) on the scope.

4. The stylus may now be returned to its rest position.

5. Adjust R-312 (Reproduce VU Level) Module #3 to obtain a reading of (-2) on the front-panel VU meter.

6. Check the level at the REPRODUCE OUTPUT test jack; it should be from 200 to 270 mv p-p.

I. AGC

1. Switch the 7029-A to the REPRODUCE mode.

2. Remove the 200 KHz filter plug-in from the 7029-A. Raise the stylus to a point midway between short points and set the mark level to zero.

3. Connect the equipment as shown in Fig. 2.2.

4. Set the output of the oscillator to obtain a reading of 0.55 volt p-p on the scope (with no attenuation in the circuit).

5. Connect a wide-band AC voltmeter to the IF OUTPUT test jack, and switch in 40 DB of attenuation. Set the AGC control at maximum, and adjust T-501 & T-502 (Module #5) for maximum output.

6. Now adjust R-509 (Module #5) to produce a reading of 2 DB below 0.1 volt rms on the AC voltmeter.

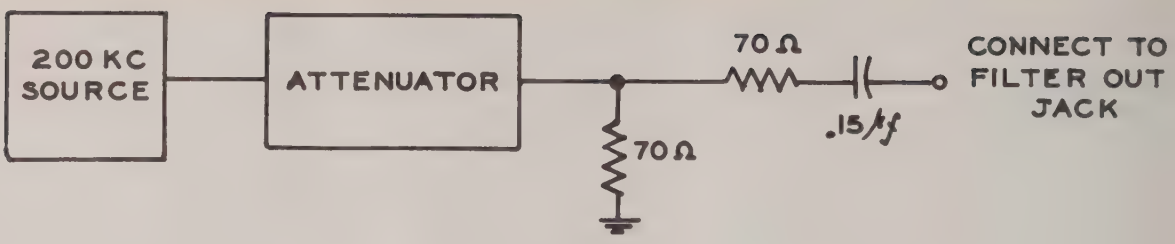


FIG. 2.2

7. Remove 20 DB of attenuation from the circuit, and adjust R-524 so that the output increases by about 7 DB from the -40 DB level.

8. Remove all attenuation from the circuit, and adjust R-503 until the output increases by about 3 DB over the -20 DB level.

9. Repeat the three preceding steps until the best results are obtained.

10. Reset the AGC control at minimum; the voltmeter should now read 1.5 volts rms ±3 DB.

11. Reset the AGC in the OFF position. Remove the 20 DB attenuation. The voltmeter should now read approximately 1.3 volts, rms.

J. MODULATOR BALANCE

1. See that the 7029-A is in the REPRODUCE mode and the BAND SELECTOR is in the NARROW position.

2. Lift the stylus to a point just above the position where the SHORT POINT indicator goes out.

3. Connect an oscilloscope to the FILTER OUTPUT test jack, and rotate the BASELINE control to obtain a peak reading on the scope.

4. Now adjust R-407 (Module #4) for a reading of approximately 150 mv p-p, while continuously varing the BASELINE control for peak output.

K. SECTIONER

1. Place the power switch in the OFF position.

2. Install six magnetic pins equally spaced around the top to the Sectioner Micrometer Plate. Loosen the two screws securing the Reed Switch Block to the Sectioner and slide the Reed Switch Block and Pointer towards the Drum. Slowly rotate the Drum by hand and position the Reed Switch Contact so that it is approximately 1/16" from by passing magnetic pin, (Fig. 2-3). Rotate the Drum 360° and see that the pins clear the switch contact by at least 1/32".

NOTE: If the magnetic pins pass too close to the Reed Switch Contact, the switch may tend to "Hang", in a closed position; if the switch is too far from the pins, the pins, the Reed Switch may fail to close.

3. Connect the equipment as described in Step 1.

4. Place the POWER and SECTIONER switches in the ON position. Place the mechanical shift lever in the reproduce position.

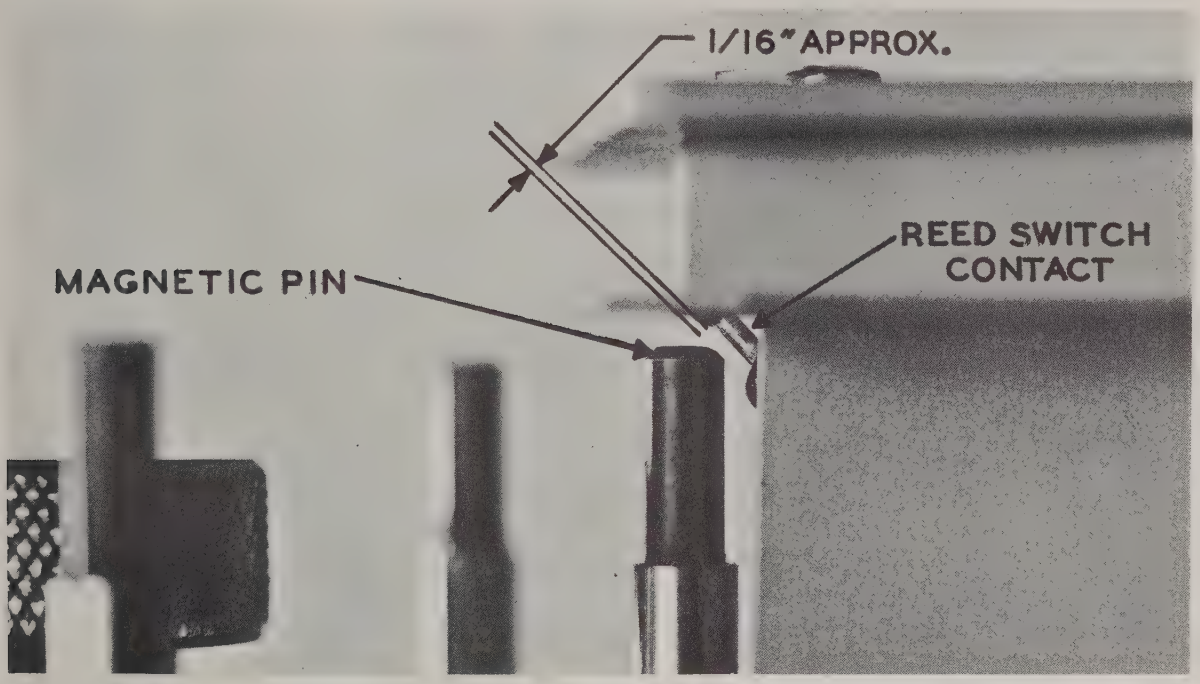


FIGURE 2.3 PROPER REED SWITCH BLOCK ADJUSTMENT

5. Connect the scope to the base of Q-803 and adjust the output of the oscillator for a negative 35 V peak exponential. (The input should be approximately .55 volts peak to peak).

6. Connect the scope to the SECTIONER OUT jack and adjust R-812 for a pulse width of 21.0 ms.

7. Switch in 35 DB of attenuation and adjust R-824 for a pulse width of 0.3 ms.

8. Repeat Steps 6 & 7 until the proper results are obtained.

2.4 ALIGNMENT PROCEDURE - AMPLITUDE DISPLAY/SCALE MAGNIFIER (6076-C)

A. EQUIPMENT REQUIRED

Sona-Graph, 7029-A
Frequency Counter, Berkeley/Beckman Mod. #554, or equiv.
DC VTVM, RCA Voltohmyst, or equiv.
AC VTVM, Ballantine Mod. #310A, or equiv.
Audio Oscillator, Hewlett-Packard Mod. 200C, or equiv.
Attenuator, 70 ohm, Kay Mod. 21-0, or equiv.

B. AMPLITUDE DISPLAY

Preliminary Settings:

Sona-Graph

ON-OFF switch - ON
SECTIONER - OFF
REC-REP switch - REP
RANGE switch - 80 Hz - 8 KHz
REC-OFF-REP switch - OFF
LIN-LOG switch - LIN
NORMAL-INVERT switch - NORMAL

Plug-In Unit, 6076-C

S-1101 - AMPLITUDE DISPLAY
NORMAL - 10 DB switch - NORMAL

1. Connect the DC Voltmeter between ground and the junction of R-1115 and R-1121.

2. Adjust R-1168 for a reading of +44 volts. Remove meter.

3. Connect the counter to P-1101, pin 7 (AMPLITUDE DISPLAY output jack).

4. Depress the BASELINE switch and adjust R-1129 for a reading of 62 KHz.

5. Connect the attenuator between the output of the audio oscillator and the reproduce output jack.

6. Connect the AC VTVM to the REPRODUCE output jack.

7. Switch in 12 db of attenuation and adjust the output of the oscillator to obtain 85 mv.

8. Adjust R-1122 to obtain 81.6 KHz.

9. Insert 12 db more attenuation and adjust R-1157 to obtain 67.0 KHz.

10. Take out 24 db and adjust R-1160 for a reading of 96.2 KHz.

11. Output frequencies should track input levels as follows:

INPUT (DB)	OUTPUT (±500 Hz)
0	96.2 KHz
-4	91.34 KHz
-8	86.48 KHz
-12 (85 mv) REF	81.6 KHz
-16	76.76 KHz
-20	71.90 KHz
-24	67.0 KHz

If necessary, repeat Steps 7, 8, and 9 to obtain above readings, utilizing R-1160 to split the

error between 91.34 and 96.2 KHz, and R-1157 to split the error between 67.0 and 71.9 KHz. 76.76 and 86.48 KHz should track if the unit is properly aligned; do not readjust for these frequencies.

C. SCALE MAGNIFIER

Preliminary Settings:

Sona-Graph 7029-A

- ON-OFF switch - ON
- SECTIONER - OFF
- REC-REP switch - REP
- RANGE switch - 80 Hz - 8 KHz
- REC-OFF-REP switch - OFF
- LIN-LOG switch - LIN
- NORMAL-INVERT switch - NORMAL

6076-A Plug-In Unit

- NORMAL-INVERT switch - NORMAL
- S-1101 - SCALE MAGNIFIER
- R-1146 - R-1153 - FULLY CCW
- UPPER LIMIT control - 000 (Fully CCW)
- LOWER LIMIT control - 000 (Fully CW)
- ZERO ADJUST - 1/3 turn from fully CW

1. Connect a counter, in series with a 100 K resistor, to the CARRIER OSCILLATOR jack inside the 7029-A, and fasten the calibration chart (See Fig. 2.4) to the drum.

2. Set the stylus at the bottom of the lead screw, and then raise it to a point where the SHORT POINT indicator just goes out.

3. Slide the calibration chart up or down the drum until its lower short line is aligned with the stylus. Do not move the chart from this position for the remainder of this procedure.

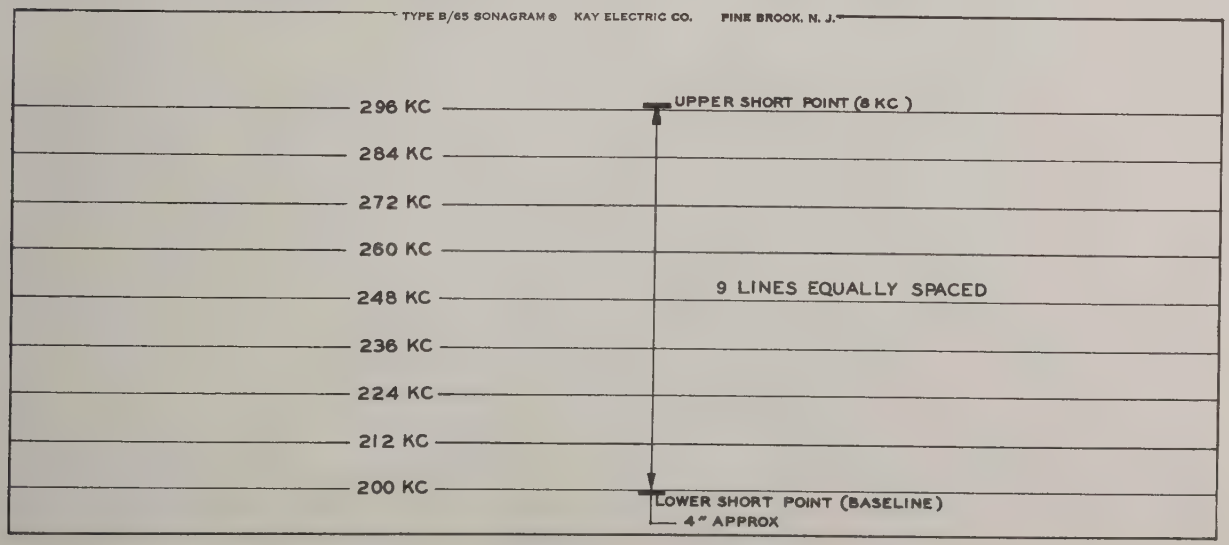


FIGURE 2.4 TYPICAL CALIBRATION CHART

4. Adjust R-1153 for 199.7 KHz on the counter.

5. Raise the stylus to the 2 KHz chart line, and adjust R-1146 for a 224 KHz reading.

6. Raise the stylus to the 4 KHz chart line, and adjust R-1148 for a 248 KHz reading.

7. Raise the stylus to the 6 KHz chart line, and adjust R-1150 for a 272 KHz reading.

8. Raise the stylus to the UPPER short point and lower it to a point where the SHORT POINT indicator just goes out. Adjust R-1152 for a 296.7 KHz reading.

9. Repeat the preceeding steps, rechecking the frequency accuracy. Touch up the adjustments if necessary.

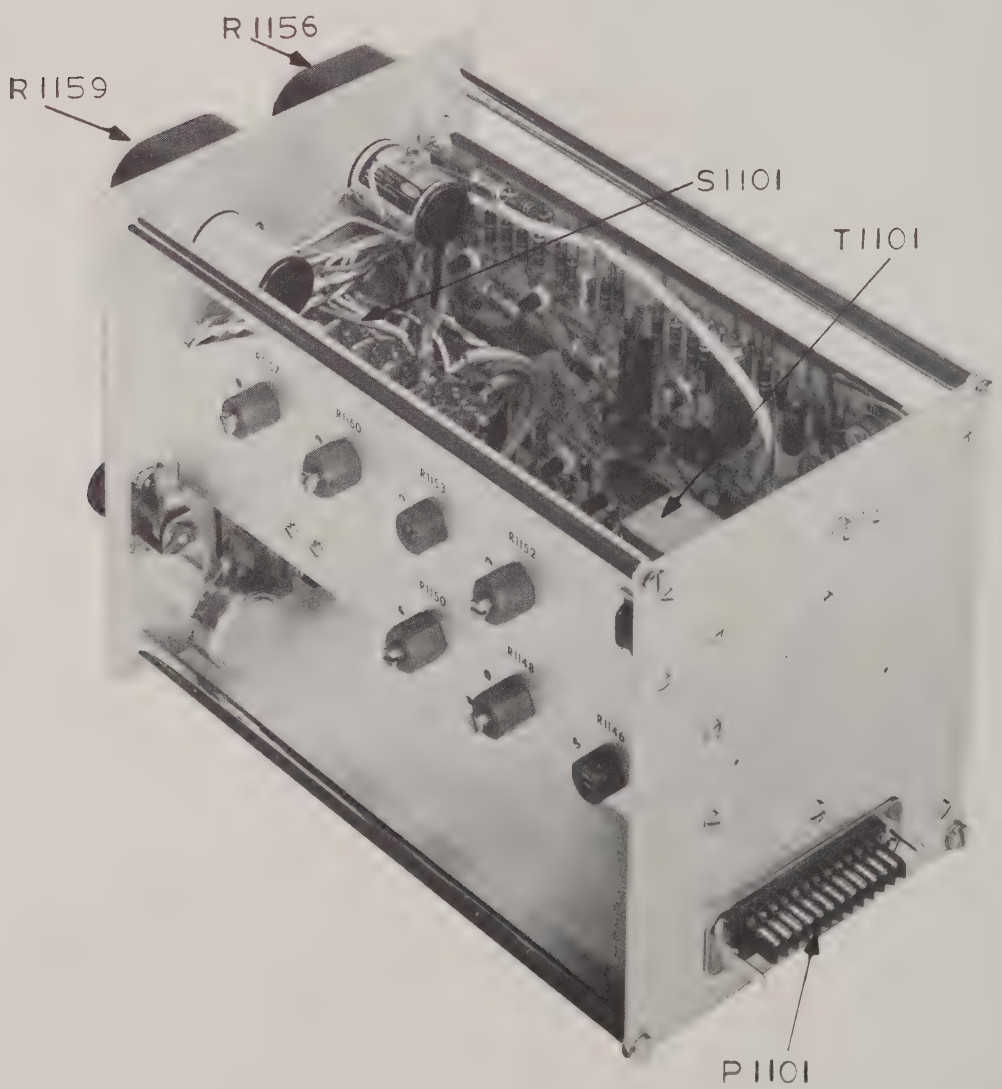


FIG. 2.5 6076-C, INTERNAL CONTROLS

SECTION III

MAINTENANCE

3.1 VISUAL INSPECTION

The 7029-A and the 6076-C plug-in should be visually inspected regularly, usually during periodic maintenance checks, for such things as loose or broken connections, cracked terminal strips, dirty recording head or surfaces, and faulty stylus adjustment. The recording surface especially should be cleaned regularly. Signs of overheating such as scorched wires or resistors, discolored casings or melted wax may indicate other less apparent troubles.

3.2 PARTS REPLACEMENT

Most components of this instrument are easily accessible and require no special replacement procedures. However, since some of the solid-state components used may be damaged when subjected to intense heat, avoid overheating when soldering the leads of these components. Long-nose pliers may be used as a heat sink between the component and the tip of the soldering iron. The soldering iron should be hot before touching the solder joint, and removed immediately after the solder flows. The tip of the iron should be electrically at ground potential so that semiconductor components having low voltage ratings will not be damaged.

3.3 PARTS LOCATION

Due to the complexity of the Sona-Graph, the electrical system has been divided into seventeen separate systems to facilitate location and replacement of parts. These individual circuits are listed below and on Figures 3.1 and 3.2. Major components designations and printed circuit component designations are screened on the chassis or module.

	Component Designation	Circuit Location
A	1-99	Main Chassis
B	100-999	Record Module #1
C	200-299	Reproduce Module #2
D	300-299	Monitor & VU Module #3
E	400-499	Carrier Osc & Modulator Module #4
F	500-599	AGC & IF Module #5
G	600-699	Bias & Calib Module #6
H	700-799	Mark Amplifier Module #7
I	800-899	Sectioner Module #8
J	900-999	Power Supply
K	1000-1099	Filter Module
L	1100-1199	6076-C Plug-in
M	1200-1299	VU Meter
N	1300-1399	Low-Pass Filter
O	1400-1499	Record Pre-amplifier
P	1500-1599	Reproduce Pre-amplifier
Q	1700-1799	LOG-LIN Freq. Adj.

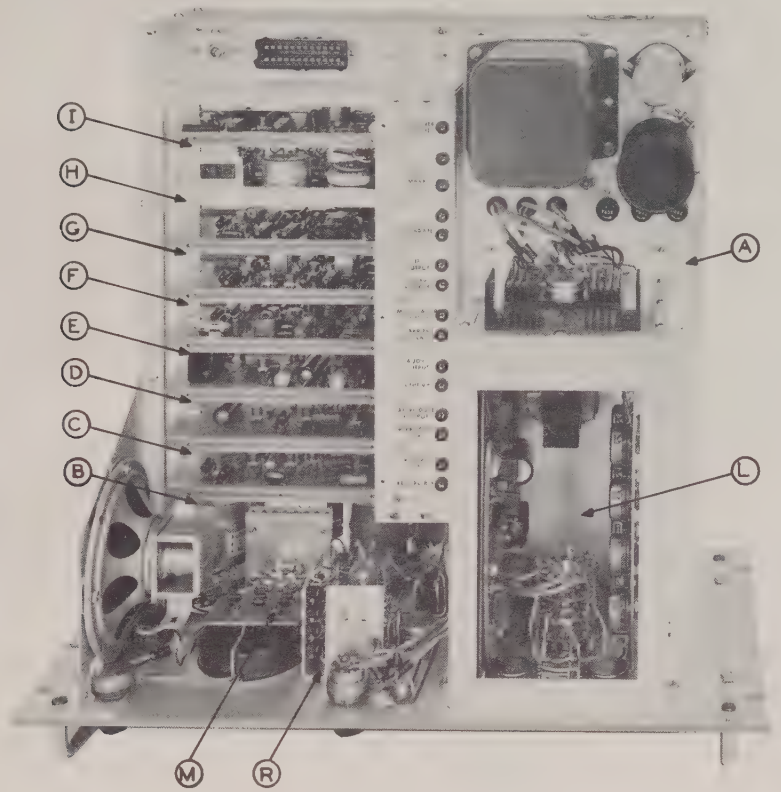


FIG. 3.1 7029-A ELECTRICAL SYSTEM, TOP

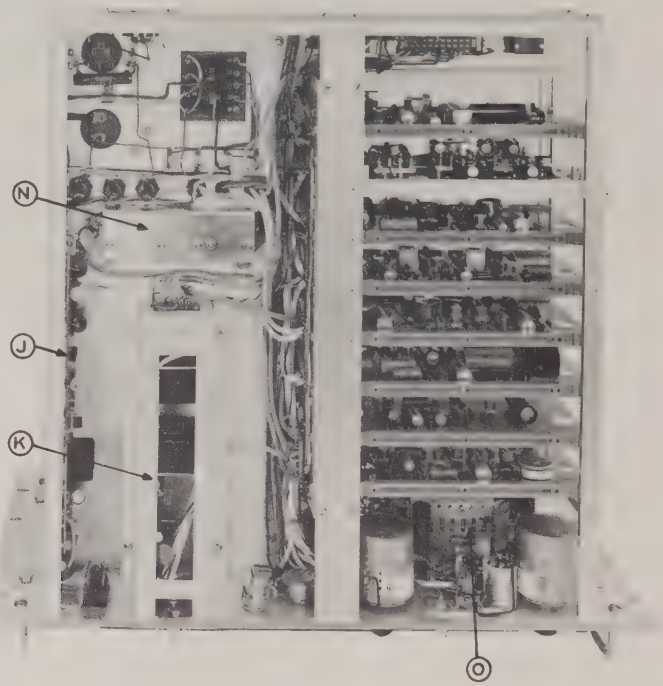


FIG. 3.2 7029-A ELECTRICAL SYSTEM, BOTTOM

3.4 DISASSEMBLY OF THE MECHANICAL SYSTEM

The following procedures are included in this section to facilitate preventive maintenance programs, but should also prove helpful when troubleshooting the instrument.

3.4.1 REMOVAL OF MECHANICAL UNIT FROM CABINET

A. Remove rear grille and disconnect multi-conductor power cable, 3-conductor Mark Amplifier cable, and 2 conductor power cable.

B. Remove (4) #4-40 screws and corner cover plate from top to unit.

C. Remove (6) #6-32 screws from top cover plate.

D. Remove REC-OFF-REP knob & RANGE SELECTOR knob. Remove the top cover plates.

E. Remove (8) #6-32 screws from the top of the mechanical system casting. The mechanical assembly is now free to remove from the cabinet.

F. Reverse procedure to reassemble mechanical system.

3.4.2 REMOVAL OF DRUM AND TURNTABLE

A. Loosen the Stylus Housing "Lock" nut, disconnect stylus drive belt and slide the housing away from the drum.

B. Loosen the Sectioner Plate lock nut and swing the Sectioner Plate away from the drum.

C. Remove the drum lock nut and Sectioner Micrometer Plate. Holding the turntable itself in a fixed position, slide the drum off over the turntable shaft.

D. Secure the Record and Erase heads away from the recording surface and hold the turntable brake back. Now lift the turntable out of the main bearing.

CAUTION: Allowing the heads to strike the turntable may throw the system out of line or may damage the heads and recording surface. When removing the turntable, maximum care should be exercised.

3.4.3 REMOVAL OF STYLUS RESISTOR

A. Remove the (4) #4-40 screws holding the Stylus Housing cover. Remove cover.

B. Remove the (2) #6-32 screws from the record head side of the housing, freeing the Stylus Resistor assembly.

C. Loosen the stylus lock nut and provide slack in the cabling.

D. Ease the entire assembly out of its cavity.

3.5 CLEANING AND LUBRICATING THE MECHANICAL SYSTEM

Cleanliness of the mechanical system of the 7029-A is essential for obtaining clear, sharp, accurate information on the Sonagram pattern. The recording head and turntable surface especially should be cleaned periodically for optimum performance.

3.5.1 CLEANING THE RECORDING SYSTEM

The Record and Erase heads and turntable should be cleaned monthly during normal operation with a clean cloth dampened with carbon tetrachloride.

3.5.2 CLEANING THE MARKING STYLUS ASSEMBLY

The housing may be cleaned periodically by removing the cover plate and blowing out any accumulated dust with compressed air. The stylus wire itself, located in the neck of the Fume Exhaust Tube, should be readjusted periodically so that proper contact is made with the paper. The lead screw which drives the stylus holder should not be allowed to run dry. A light coat of petrolatum should be applied to the lead screw and the excess lubricant removed with a clean cloth. A drop or two of light oil should be applied to the bearings which support the lead screw whenever the lead screw itself is lubricated.

3.5.3 EXHAUST SYSTEM

The Exhaust Tube itself should be cleaned as required to permit passage of air through the exhaust system. The blower motor on the underside of the mechanical system casting should be oiled every six months with light machine oil. If, with the blower operating, the fumes from the recording process are not drawn off through the exhaust hose, the filter may be clogged. This should be corrected by replacing the filter unit.

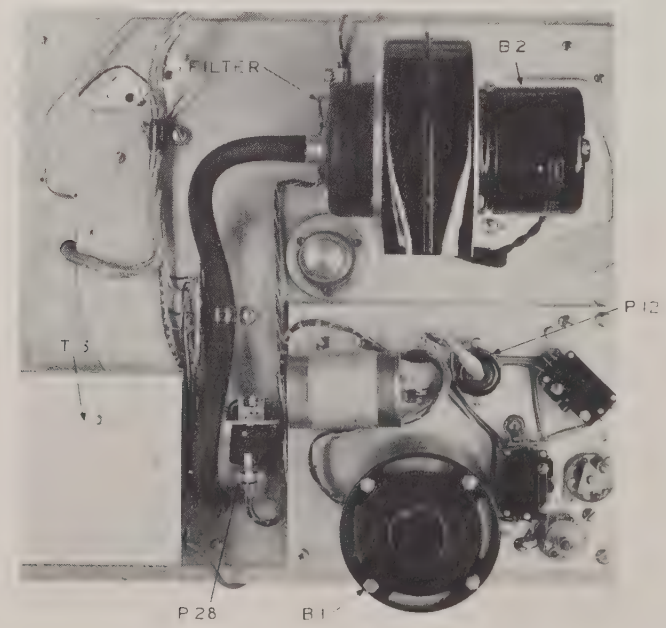


FIG. 3.3 MECHANICAL ASSEMBLY, BOTTOM

3.5.4 DRIVE SYSTEM MAINTENANCE

Remove the drum and turntable as indicated in paragraph 3.4.2. The drive wheels may now be cleaned with a clean cloth dampened in alcohol.

3.6 TROUBLESHOOTING DATA

This section contains information, voltage charts, and call-out photographs for use in servicing the Sona-Graph. To minimize unnecessary labor, try to use the alignment and preventive maintenance procedures before attempting any repairs. Certain abnormalities can be compensated for, using the proper adjustments.

To maintain the reliability of this instrument, always realign any portion that has been repaired. If the power supply circuits have been serviced, it is wise to perform the check-outs in the Operator's Manual, if these checks reveal that functions are not within specifications, follow the appropriate portion of the alignment procedure.

UNIT IS BOTH ELECTRICALLY AND MECHANICALLY INOPERATIVE

If the pilot lamp is out and the mechanical system fails to operate, check fuses F-2 and F-1, the line cord, the POWER switch, and Plug-Jack 901 combination for continuity. Check also to see the plug-in unit is firmly seated in its cavity.

UNIT IS MECHANICALLY INOPERATIVE, BUT ELECTRICALLY NORMAL

Check the continuity of PJ-14 pins 1 & 4, PJ-12, and PJ-15. If these checks fail to reveal an open circuit, check the continuity of the motor (B-1) itself.

MECHANICAL SYSTEM IS NORMAL; NO SIGNAL CAN BE RECORDED

If the pilot lamp is out, check the continuity of the power transformer primary.

If the pilot lamp is on and the VU meter does not give any indication, check to see if the short point lamp is lit with the electrical in REPRODUCE mode and the stylus at the bottom of its travel. If the SHORT POINT indicator does not light, check Fuse F-3 and the +18 volt supply circuit for proper DC levels. The levels should be similar to those given below.

TRANSISTOR	EMITTER	BASE	COLLECTOR
Q1	+18.0	+18.9	+31.0
Q901	+19.4	+20.0	+31.0
Q902	+ 6.5	+ 7.0	+20.0
Q903	+18.9	+19.4	+31.0

If the above checks fail, check T-1 secondary and diodes CR-1 thru CR-4.

If the SHORT POINT indicator lights, check the gain of the record amplifiers as follows:

Feed a audio signal of 2.5 KHz into the INPUT jack and adjust the oscillator for an output of 300 mv peak-to-peak. With the RECORD LEVEL set to approximately "20", connect a scope to pin 5 of PJ1. Gain voltages similar to those found on schematic B-7756 should be obtained. DC levels (±10%) are given in the table below.

TRANSISTOR	EMITTER	BASE	COLLECTOR
Q1401	+2.9	+3.5	+ 9.3
Q1402	+8.7	+9.3	+18.0
Q101	+3.6	+4.2	+ 7.2
Q102	+6.6	+7.2	+11.2
Q103	-1.8	-1.1	+18.0
Q104	-1.5	-0.9	+ 8.0
Q105	+7.3	+8.0	+18.0

If a meter indication and proper output at pin 2 of Module #1 is obtained, check the continuity of record head PU-1, check also to see that proper bias is obtained per the alignment precedure. The following DC levels are typical of the biasing circuits.

TRANSISTOR	EMITTER	BASE	COLLECTOR
Q205	0	-7	+15
Q206	0	-7	+15

UNIT FAILS TO ERASE PROPERLY

Check the DC levels as noted above and the continuity of Erase Head, PU-2.

PLAYBACK SIGNAL IS NOT PRESENT

If the system fails to mark the paper and the monitoring systems (VU meter and speaker) do not indicate normal signal strength, check the REPRODUCE PRE-AMPLIFIERS Q1601, Q1602, and Q1603, the REPRODUCE AMPLIFIERS on Module #2, and the continuity of the low pass filter. Refer to the table below for approximate DC levels.

TRANSISTOR	EMITTER	BASE	COLLECTOR
Q1601	-0.6	0	+ 6.8
Q1602	+4.5	+5.1	+ 7.3
Q1603	+6.7	+7.3	+18.0
Q201	+3.7	+4.3	+ 6.8
Q202	+3.4	+4.0	+ 7.5
Q203	+6.0	+6.7	+ 9.9
Q204	+9.2	+9.9	+18.0

SYSTEM FAILS TO MARK PAPER:
RECORD AND REPRODUCE FUNCTIONS ARE NORMAL

Check first the stylus wire itself to make sure it is making contact with the paper and the 3-conductor MARK AMPLIFIER cable to ascertain that it is properly connected to its jack on Module #7.

If these checks fail to reveal the source of trouble, check the circuitry of the CARRIER OSCILLATOR AND MODULATOR Module #4 by connecting an oscilloscope to the CARRIER OSCILLATOR OUTPUT TJ-19. With the stylus slightly above the lower short point, the FREQ. SCALE switches in the LIN and NORMAL positions and accessory plug-in function switch in the OFF position, an output of approximately 25 volts peak-to-peak at 200 KHz should be obained. Raise the stylus slowly and note a constant change in frequency. If the rate of change is abnormal, check the stylus resistor circuitry for continuity. If no output is obtained, check the characteristics of the oscillator and output stages of Module #4. Typical readings are given below.

TRANSISTOR	EMITTER	BASE	COLLECTOR
Q401	+ 8.5	7.8	+14.6
Q402	+ 2.5	2.5	+16.5
Q403	+17.4	+17.9	+18.0
Q404	+ 3.1	3.0	+17.9
Q405	+ 3.3	+ 3.9	+ 7.8

If Module #4 is operating satisfactorily, check the circuitry of MARK AMPLIFIER Module #7 and AGC-IF Module #5 as follows.

Record and reproduce a 2.5 KHz signal at "0" VU. Set the AGC control to "0" and the MARK LEVEL to "2". Connect an oscilloscope to FILTER OUT test jack, TY-25. Raise the stylus to a point at which the 2.5 KHz signal peaks (with the mechanical system in reproduce) at approx. .55 volts peak-to-peak. If this reading is not obtained, check the DC, levels of Q1001 thru Q1003 using the table below.

TRANSISTOR	EMITTER	BASE	COLLECTOR
Q1001	1.5	2.1	8.1
Q1002	2.0	2.6	10.4
Q1003	9.6	10.4	18.0

If the FILTER OUTPUT is normal connect the scope to TJ-21 (IF OUTPUT), raise the stylus to the point at which the 2.5 KHz signal is obtained. If an output of approx. 4.9 volts is not noted on the scope, check the DC levels on Module #5.

TRANSISTOR	EMITTER	BASE	COLLECTOR
Q501-502	Conditions vary depending on AGC action involved.		
Q503	1.4	1.9	10.7
Q504	4.7	5.3	16.5
Q505	1.9	2.5	5.3

If the IF output is normal, check the DC levels of MARK AMPLIFIER Module #7. Typical readings are given in the table below.

TRANSISTOR	EMITTER	BASE	COLLECTOR
Q701	4.0		17.0
Q702	4.4		15.0
Q704-5	levels vary - B+ is unregulated		

SECTIONER FAILS TO FUNCTION

If the SECTIONER portion fails to operate normally, first check the Reed Switch Block to see that it is properly adjusted and that it closes as a Magnetic Pin passes it. This may be checked by connecting an ohmmeter across the terminals on the Reed Switch Block and rotating the drum by hand. Finally, check the continuity of CR801, CR802, and K801 and DC levels of Module #8.

TRANSISTOR	EMITTER	BASE	COLLECTOR
Q801	2.4	3.0	8.0
Q802	7.5	8.0	16.0
Q803	2.0	2.6	16.0
Q804	-1.0	- .2	0
Q805	-1.0	- .5	-1.5
Q806	1.3	-1.6	17.0
Q807	1.3	1.8	+1.4

MONITOR SYSTEM FAILS TO FUNCTION

If the SONA-GRAPH is working normally but the VU and speaker systems fail to operate, check the circuitry of Module #3. Typical DC levels are included in the table below.

TRANSISTOR	EMITTER	BASE	COLLECTOR
Q301	2.7 $\pm$1.3	3.5 $\pm$1.3	11.4 $\pm$2
Q302	3.8 $\pm$ .3	4.5	9.0 $\pm$1
Q303	5.4 $\pm$1	6.0	7.4 $\pm$1
Q304	2.6 $\pm$ .3	3.3	8.2 $\pm$1
Q305	2.9 $\pm$ .3	3.5	18
Q306	2.3 $\pm$ .3	2.9	17

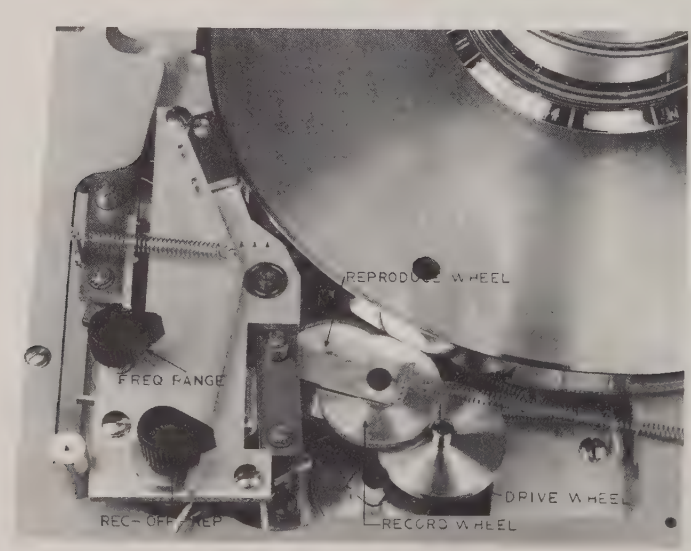


FIG. 3.2 MECHANICAL DRIVE SYSTEM

FREQUENCY VARIATIONS NOTED IN CALIBRATION LINES

The RECORD-OFF-REPRODUCE SELECTOR switch should be left in the OFF (neutral) position when the SONA-GRAPH is not in use to prevent a flat from developing on the drive wheels, which will appear as excessive "wow" on the Sonagram. Excessive variations in the calibration lines indicates that the drive wheels are dirty. The wheels may be cleaned by using a clean cloth dampened with alcohol (the use of carbon tetrachloride is not suggested, as it will damage the high friction material on the drive wheels).

3.7 RESHIPMENT INSTRUCTIONS

Permission to return equipment should be obtained from the factory or an accredited Kay representative before return shipment is made. If it is necessary to return the 7029-A or 6076-C for repair, pad it securely for transit. A packing slip should be included in the carton furnishing identification of the shipper, as well as the instrument type and serial number. Also, include a statement indicating the malfunction for the benefit of service personnel.